Progress Report

for

SBIR Topic # *N091-003*

Topic Title: ULTRA HIGH RESOLUTION DYNAMIC FOVEAL VISION DISPLAY

Contract Number: M67854-09-C-6538

For the MCSC SBIR Program Office
Prepared for: Paul Lambert, PM
Email: paul.a.lambert@usmc.mil
Government TPOC: Ryan Kresse
Email: Ryan.kresse@usmc.mil

Prepared by: Jesse B. Eichenlaub
Dimension Technologies Inc.
315 Mount Read Blvd., Rochester, NY 14611
As of January 23, 2010
Company PI: Jesse B. Eichenlaub
Phone: 585-436-3530
Email: jbe@dti3d.com

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Eichenlaub, Jesse B.

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Dimension Technologies Inc.
315 Mount Read Blvd.
Rochester, NY 14611

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14. ABSTRACT

This Navy Small Business Innovation Research Phase I project will be used to fabricate, measure, and test a novel optical design for use in a new type of ultra-high-definition (UHD) head mounted virtual reality display (HMD) that can incorporate a UHD AOI feature without moving parts or extra displays. DTI has demonstrated a large screen (UHD) projection technology that uses a rapidly scanned microdisplay to produce images possessing much more resolution than the microdisplay itself. It accomplishes this by illuminating different sub regions of each pixel during each scan, producing an image made up of the sub regions instead of the pixels. During this project DTI will investigate and bench test a novel illumination and optical system that can produce arrays of sub-pixel sized illumination spots on off the shelf microdisplays in a very compact space. This system will then be operated in conjunction with an eye tracker to demonstrate a moveable high resolution foveal insert in a lower resolution field on an off the shelf microdisplay. DTI will also investigate adaptation of the system to an existing head mounted system.

15. SUBJECT TERMS
Area of interest, AOI, HMD, Head mounted, foveal vision display, simulation, microdisplay, DLP

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U	U	U			585-436-3530

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Concept Description

This Navy Small Business Innovation Research Phase I project will be used to fabricate, measure, and test a novel optical design for use in a new type of ultra high-definition (UHD) head mounted virtual reality display (HMD) that can incorporate a UHD AOI feature without moving parts or extra displays. DTI has demonstrated a large screen (UHD) projection technology that uses a rapidly scanned microdisplay to produce images possessing much more resolution than the microdisplay itself. It accomplishes this by illuminating different sub regions of each pixel during each scan, producing an image made up of the sub regions instead of the pixels. During this project DTI will investigate and bench test a novel illumination and optical system will that can produce arrays of sub-pixel sized illumination spots on off the shelf microdisplays in a very compact space. This system will then be operated in conjunction with an eye tracker to demonstrate a moveable high resolution foveal insert in a lower resolution field on an off the shelf microdisplay. DTI will also investigate adaptation of the system to an exiting head mounted system.

The feasibility study proposed would lead to the development of HMDs aimed at dismounted Marine applications plus a wide variety of other markets such as simulation and training. The technology will address two important issues related to head mounted display systems. First, users in many applications want to see with eye limited resolution, but the current state of the art in microdisplays is such that the user must trade FOV for resolution. Secondly the resolution of many cameras far outstrips the resolution available in the highest resolution microdisplays, preventing operators from taking full advantage of the resolution available. High quality, low cost, and low bulk ultra high resolution HMDs could open new markets in a wide variety of applications where HMDs are not widely used today. Examples include driving, flying, and ship piloting training for military and civilian markets as well as consumer electronic game markets.

Technical Accomplishments

Talbot Plane Imaging

Micro lens Array

No further activity was necessary

Analyze Talbot plane imaging design

Investigations were conducted into the fabrication of beamsplitters where polarizing beamsplitting function and the dichroic reflection functions could be combined on the same diagonal sufaces within a single beamsplitter. This would result in a much shorter light path between the fly's eye lens and the microdisplay, which has certain optical advantages as well as slightly decreasing volume and weight. The feasibility of custom manufacturing such beamsplitters looks promising. The previous working design required a separate stack of dichroic mirrors that sent light from the fly's eye lens back through the beamsplitter a second time.

Investigate laser light sources

Investigations of laser diode sources with Bragg reflectors for wavelength temperature stability were completed. A number of laser diode sources have been identified.

A promising means was identified for the elimination of speckle without moving parts. This means involves using the operation of the microdisplay pixels themselves to continuously change the phase of laser light reflecting from different pixels, plus the possible use of a secondary element to produce a greater effect of the same time. This would produce the same effect as a moving diffuser: The speckle pattern would change randomly and so rapidly that to the observer it would appear to be smoothed out.

One remaining issue with regard to wavelength drift with temperature was analyzed. The distance from the microlens array at which the spots are focused is very sensitive to temperature variations, which is why Bragg reflectors for wavelength stabilization will be used. Since a system designed for use by Marines would require a very wide operating temperature range, some additional means is desirable to cause the microdisplay to remain at the spot focal plane throughout this wider range. A simple solution that involves thermal expansion and contraction of the structure the microdisplay is mounted to was investigated. Thermal expansion of common materials, such as plastics, seem to be within the range necessary to counteract Talbot plane drift due to wavelength changes associated with temperature change.

Develop Evaluation Test Stand

Optical Configuration

DTI reviewed its preferred overall optical arrangement, involving a “mini projector” design with Sage Technologies. They believe that the concept is workable and could be fitted into their helmet systems.

Microdisplay Investigations

Investigations with Forth Dimension Displays were completed. Descriptions of possible avenues for further power reduction suggested by Sage Technologies (see below) were provided to them for review and comment.

Electronics and Power Requirement investigations

Discussions of the power requirements of various systems with Sage Technologies resulted in possible avenues for significant power reduction for the microdisplay interface, which is the most power hungry component in the display system. The engineer at Sage’s Technologies felt that a ½ - ¾ power reduction could potentially be obtained if an interface that was specifically designed for our display method and application was designed. One problem with the current 4DD design is that it is a commercial system that has to work for everyone across multiple applications.

Weights

Better estimates for the likely weights of structural components caused us to revise the total weight estimates of the system downward. Weight estimates are within the goals set by MARCOR.

Technical Issues

Problems / Issues:

All remaining issues, such as detailed investigation of dedicated interface designs for power reduction, detailed optical design, and detailed mechanical design will be performed during Phase II. We believe that the Phase I results indicate that the concept is feasible and provide a firm foundation for the Interim Project and establishing a solid baseline for Phase II.

Future Efforts:

The Phase I program has been completed with the exception of the Program Review and Final Report. The Program Review is in process and currently scheduled on the 18th of February, 2010. After the Program Review is completed any further work will be carried out in the interim project and provide an established baseline and solid foundation in Phase II.

Project Schedule: Marine/AOI M67854-09-C-6538 Gantt